Ostenso, Nile A - DNR

From:	Metcalf, Mark W <MWMetcalf@integrysgroup.com>
Sent:	Friday, April 12, 2013 3:15 PM
To:	Ostenso, Nile A - DNR
Cc:	Mugan, Tom J - DNR; Singletary, Lynn L - DNR
Subject:	RE: Pulliam mercury variance comment letter
Attachments:	20130412 response to EPA PMP comments.pdf

Hi Nile,

WPSC has reviewed EPA's March 22, 2013 letter on the mercury pollutant minimization plan for the Pulliam plant. Attached please find responses and additional information related to the questions and comments posed by EPA. Feel free to contact me if you have questions.

Have a good weekend,

Mark

Mark Metcalf
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Providing support for Integrys Energy Group, Integrys Energy Services, Michigan Gas Utilities, Minnesota Energy Resources, North Shore Gas, Peoples Gas, Trillium CNG, Upper Peninsula Power Company and Wisconsin Public Service.

From: Ostenso, Nile A - DNR [mailto:Nile.Ostenso@Wisconsin.gov]
Sent: Monday, March 25, 2013 2:01 PM
To: Metcalf, Mark W
Cc: Mugan, Tom J - DNR; Singletary, Lynn L - DNR
Subject: FW: Pulliam mercury variance comment letter

Hi Mark,

Attached are EPA's initial comments on the public noticed permit with respect to the requested Hg variance.

Please provide your response to the points made. Please respond as soon as possible so the permit can be reissued by the effective date in the public notice. It is not clear if you changed your source of sulfuric acid?

EPA is requesting that section 5.2 Mercury Pollution Minimization Program, in the compliance schedule be more explicit. The following suggested language is added for your comment:

a. Source identification: include a quantified mass-balance of all sources of mercury at the facility and include a quantified mass-balance of all mercury introduced to the environment through operation of the facility.

If you have questions, please contact me.

Thanks,

Nile A. Ostenso

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From: Anson, Robie [mailto:anson.robie@epa.gov]
Sent: Friday, March 22, 2013 3:39 PM
To: Ostenso, Nile A - DNR; Mugan, Tom J - DNR; Singletary, Lynn L - DNR
Subject: Pulliam mercury variance comment letter

Hi Nile, Tom, and Lynn:

We sent the attached comment letter today. Please feel free to contact me with questions or comments.

Have a good weekend,

Robie Anson
US EPA Region 5
Water Quality Branch WQ-16J
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On March 22, 2013, U.S. EPA provided comments to Susan Sylvester of the Wisconsin Department of Natural Resources (WDNR) on the mercury pollutant minimization program plan for the WPSC J.P. Pulliam plant. The comments were provided during the WPDES permit renewal public comment period. The following is a response to the questions and comments within the letter.

<u>Question 1:</u> From where does WPSC draw water used in cooling? Please describe the path this water takes in the facility from intake to discharge, including any treatment.

<u>Response</u>: The facility has two intake structures: one on Green Bay and another that withdraws water from the Fox River. The Fox River intake is currently used as the intake water source but the Green Bay intake could be used if needed. The primary use of water withdrawn from the Fox River or Green Bay is for once-through condenser cooling. Water withdrawn from the Fox River is returned to the Fox River near the confluence of the river and Green Bay. Condenser cooling water is not "treated," but the facility does chlorinate and de-chlorinate the water periodically as allowed by the WPDES permit. The water balance diagram submitted with the WPDES permit renewal application is attached for reference (Attachment 1).

<u>Question 2:</u> From where does WPSC draw water used in boiler blowdown? Please describe the path this water takes in the facility from intake to discharge, including any treatment.

<u>Response</u>: Water used in the boiler is potable water purchased from the City of Green Bay. Prior to use in the boiler, the water is treated by a demineralizer system. The demineralizer system is comprised of cation, anion, and mixed bed exchange tanks. Demineralizer rejection water and boiler blowdown are directed to an on-site wastewater treatment facility that consists of settling basins and lamella clarifiers with polymer injection for the removal of suspended solids. The wastewater treatment facility discharge combines with the condenser cooling water discharge prior to plant Outfall 001. A diagram depicting the wastewater treatment facility submitted with the WPDES permit renewal application is attached for reference (Attachment 2).

<u>Question 3:</u> From where does WPSC draw water used in demineralization? Please describe the path this water takes in the facility from intake to discharge, including any treatment.

<u>Response</u>: see above response to Q2.

<u>Question 4:</u> From where does WPSC draw water used in any other processes not explicitly noted above? Please describe the path this water takes in the facility from intake to discharge, including any treatment.

Response: Water used for other purposes, such as traveling screen wash waster, bearing cooling, coal pile fugitive dust control and bottom ash sluicing is obtained from the Fox River intake. Non-contact cooling water and traveling screen wash water is not treated (other than the periodic chlorination/dechlorination described above) before being returned to Outfall 001. Process wastewater, such as boiler blowdown, bottom ash sluice water, and boiler seal water are directed to the wastewater treatment facility. The water used for coal pile fugitive dust control either evaporates or is treated by the wastewater treatment facility before being returned to Outfall 001.

Question 5: Does the mercury concentration in "wastewater treatment facility influent" reported on page 2 of the facility's 2010 annual report reflect mercury level in the facility's process water?

Response: The mercury concentration reported for the "wastewater treatment facility influent" in the 2010 annual status report reflects the concentration of mercury in a grab sample of process wastewater collected after the on-site settling basins and prior to the wastewater treatment facility lamella clarifiers.

Question 6: Does the mercury concentration in "wastewater treatment facility effluent" reported on page 2 of the facility's 2010 annual report reflect mercury level in treated process water only, prior to mixing with non-contact cooling water?

Response: The mercury concentration reported for the "wastewater treatment facility effluent" in the 2010 annual status report reflects the concentration of mercury in a grab sample of process wastewater only. The sample was collected from the discharge of the wastewater treatment facility prior to mixing with non-contact cooling water.

Question 7: How much data has the permittee collected on the level of mercury in wastewater treatment facility influent and effluent?

Response: The facility collected a one-time set of data from both the influent and effluent of the wastewater treatment facility in 2009 as part of the mercury PMP source identification process. This data was reported in the 2010 annual status report.

Comment 8: In addition, should WDNR choose to approve WPSC's request for a mercury variance, please provide the following for EPA review: a schematic diagram of the facility, its processes, and all waste streams.

Response: A flow diagram and schematic diagram of the facility's wastewater treatment system was provided as part of the WPDES permit renewal application. Refer to Attachments 1 and 2.

<u>Comment 9</u>: Please provide the following for EPA review: documentation of the mass of mercury that the facility introduces to the environment on an annual basis and associated calculations and assumptions.

<u>Response</u>: The utility monitors the combined discharge from the facility at WPDES Outfall 001. This outfall consists of both the condenser cooling water and process wastewater. The monitoring data collected at this outfall therefore represents the total mercury in the water, which includes mercury in the ambient water along with any potential mercury added as a result of plant operations.

Although the plant's currently approved PMP does not require the monitoring of all internal waste streams, the proposed WPDES permit will require monitoring of the facility's process wastewater for mercury and requires influent wastewater monitoring as part of the PMP. This additional monitoring will allow the facility to document the amount of mercury introduced into the environment through the facility's wastewater discharge. WPSC has gone beyond the PMP requirements and monitors both the intake and combined outfall discharge from the facility on a monthly basis. Initially, it would appear that with this information the amount of mercury the plant introduces into the environment could be calculated. Therefore, in response to this request, WPSC calculated the mass of mercury in both the intake water and discharge water from the facility using the following calculation as found in the WPDES permit:

Discharge volume (Million gallons) * 8.34 lbs/gallon water * Concentration (mg/l) = lbs mercury

Attachment 3 provides the results of this calculation.

A review of the 2012 data in attachment 3 shows that on an annual basis, the average concentration of mercury in the intake is higher than the annual average concentration of mercury in the discharge. There are months when the Outfall 001 has a slightly higher concentration than the intake water and there are months when the Outfall 001 has a lower concentration than the intake water. Therefore, from a mathematical standpoint it appears that the facility may be adding mercury some months and removing mercury during others months.

After comparing the results of the monthly intake and discharge mercury concentration calculations, it can be concluded that there is no statistical difference between the intake and outfall concentrations. WPSC analyzed the two data sets (intake and outfall) using the correlation coefficient analysis of Microsoft Excel. The analysis resulted in a correlation coefficient of 0.889, which means the values are highly correlated and thus the concentrations observed at the outfall are directly related to the concentration of mercury in the intake water. However, using the monthly concentration results, it is clear that there is no indication the facility is contributing mercury to the Fox River.

<u>Comment 10</u>: Please provide the following for EPA review: documentation of the annual decrease in the mass of mercury introduced to the environment as a result of mercury reduction initiatives implemented since the approval of the permittee's PMP in 2009 and associated calculations and assumptions.

Response: As explained in response to Q9, the facility has only been required by the PMP to monitor the combined discharge from the facility (at WPDES Outfall 001). Thus, there is no documentation detailing how much mercury the plant introduces or removes from the environment. However, WPSC has initiated efforts to reduce the amount of mercury that could be introduced into the environment from the facility.

As indicated in the 2010 PMP status report, WPSC changed the chemical specification for sodium hydroxide so that the maximum acceptable level of mercury in the chemical was reduced from 0.5 mg/l (ppm) to 0.002 ppm, a 99.6% reduction. Between 2010 and 2012, the facility purchased 727,460 lbs of sodium hydroxide. Making an assumption that if the sodium hydroxide was 0.5 ppm, the potential amount of mercury in the product purchased would be 0.364 lbs (727,460 lbs H2SO4/1,000,000 * 0.5 ppm). In contrast, if it is assumed that all of the sodium hydroxide had a mercury concentration of 0.002 ppm, then the potential amount of mercury in the product purchased would be 0.001 lbs (727,460 lbs H2SO4/1,000,000 * 0.002 ppm). This chemical specification change alone resulted in a reduction of mercury potentially introduced to the environment of 0.362 lbs. The exact mercury reduction could be even more, however, since the chemical manufacturers do not provide analytical data on the concentration of mercury in each batch of chemicals received.

Comment 11: Please provide the following for EPA review: the calculations and assumptions used to estimate the cost of implementing each of the four mercury reduction options discussed on page 3 of Pulliam's January 29, 2010 annual report;

Response: As provided in the 2010 annual status report, the estimated costs of the four mercury reduction options are the capital costs associated with the installation of equipment. Annual operation and maintenance (O&M) dollars are not included. The estimated capital costs were based upon an engineering evaluation conducted by a contractor. Select pages from the engineering report with the calculations and assumptions are included in (Attachment 4).

Comment 12: Please provide the following for EPA review: an explanation of why the permittee has not replaced sulfuric acid used in the facility with a low-mercury alternative.

Response: First, it should be noted that WPSC does have specifications for the maximum levels of Hg in both the sulfuric acid and sodium hydroxide used at the facility. The current specification is 1.0 mg/l Hg in sulfuric acid and 0.002 mg/l in sodium hydroxide. As this is the maximum specification, the actual concentration in the chemicals received at the facility is typically less.

With regards to sulfuric acid, in 2010 WPSC worked with the chemical vendor to try and obtain sulfuric acid with a lower concentration of mercury by reducing the chemical specification. When the January 29, 2010 PMP status report was submitted, the vendor had indicated lower Hg content sulfuric acid was available. However, in subsequent conversations with the vendor, the vendor indicated they were not able to guarantee delivery of higher grade sulfuric acid as they have multiple suppliers with varying specifications for mercury concentration. Consequently, the specification was not changed.

In 2012, WPSC received a higher grade sulfuric acid. Based on information supplied by the vendor the sulfuric acid delivered to the site has a specification of <0.1 ppm mercury, and testing of the acid has shown levels of less than 0.01 ppm mercury. Unfortunately, the chemical certificates of analysis received from the manufacturer do not always contain the concentration of mercury in the product. WPSC is working with the vendor to try and address this issue.

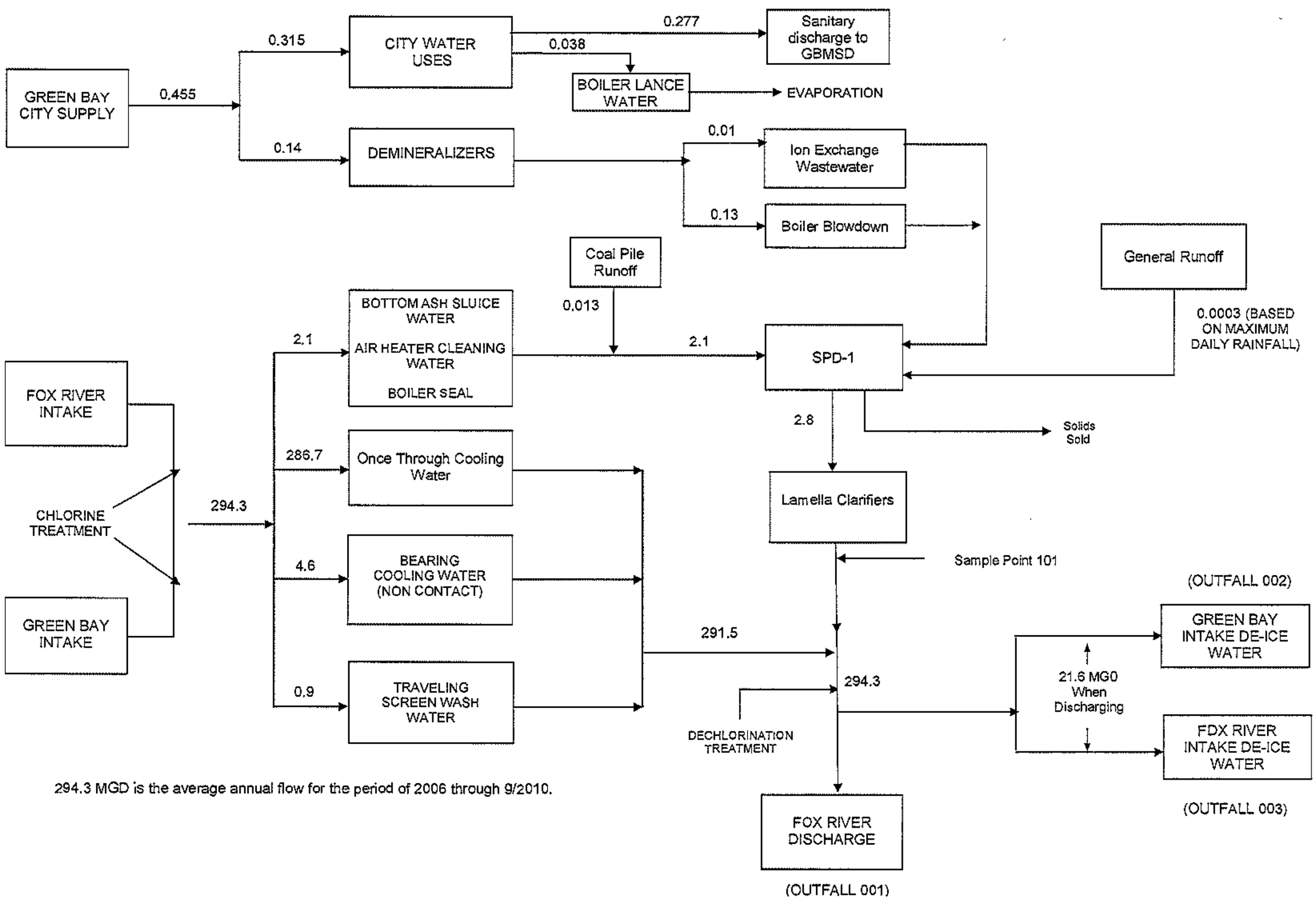
Comment 13: Please provide the following for EPA review: an explanation of the specific mercury reduction activities that the permittee will conduct within the next five-year permit cycle, including a relative timeline for carrying out the work.

Response: The proposed permit contains a compliance schedule relative to the mercury PMP. As part of the compliance schedule in the proposed permit, WPSC is required to propose an updated PMP that includes elements such as source identification, material substitution with low mercury alternatives, alternate processes, and influent wastewater monitoring to determine potential sources of mercury contributing to the discharge. Submittal of the updated PMP is due within 3 months of the effective date of the permit. The Department will review and notify the permittee of acceptance or provide additional comments on the proposed PMP and will then address timing of compliance activities. The results of investigation and/or activities related to the PMP will be provided in the annual status report.

ATTACHMENT 1

J.P. Pulliam Power Plant
WPDES Permit No. WI-0000965-08

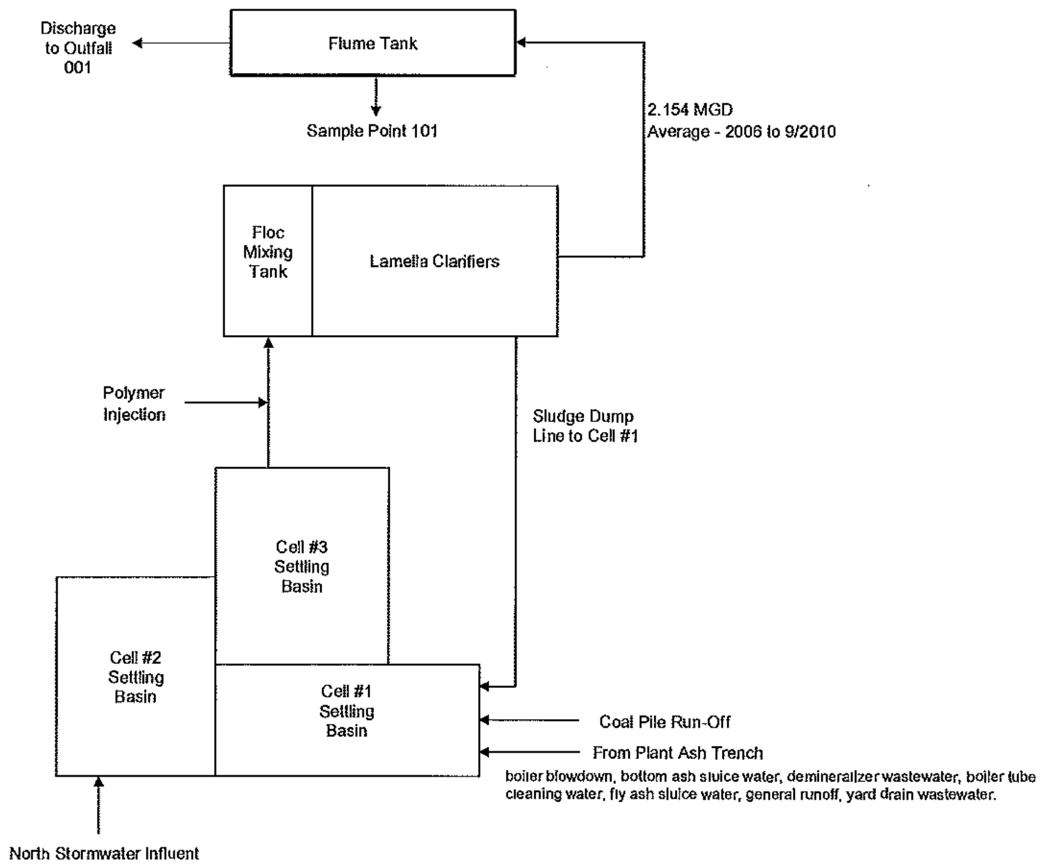
Note: All flows in MGD unless otherwise noted.



294.3 MGD is the average annual flow for the period of 2006 through 9/2010.

ATTACHMENT 2

WPSC Pulliam Plant - Waste Water Facility One-Line Diagram



Attachment 3

Month	Plant Discharge (Mgal/month)	WWF discharge Mgal/month	Intake Hg concentration (ng/l)	Effluent Hg concentration (ng/l)	Total Mass of Hg in Intake (lbs/month)	Total Mass of Hg in effluent (lbs/month)	Total Mass of Hg introduced/removed (lbs/month)
January	1,747.6	32.5	2.24	2.4	0.033	0.035	0.002
February	1,887.3	35.0	1.17	1.51	0.018	0.024	0.005
March	1,608.7	59.3	3.29	3.25	0.044	0.044	-0.001
April	1,386.1	40.3	2.95	3.59	0.034	0.042	0.007
May	5,341.8	54.0	6.09	10.5	0.271	0.468	0.196
June	4,283.9	46.0	9.36	14.5	0.334	0.518	0.184
July	8,988.0	55.0	15.80	17.3	1.184	1.297	0.112
August	6,625.0	47.9	28.20	31.8	1.558	1.757	0.199
September	3,526.9	42.9	34.80	16.7	1.024	0.491	-0.532
October	1,125.1	31.5	14.90	10.5	0.140	0.099	-0.041
November	3,932.8	36.2	37.70	34.4	1.237	1.128	-0.108
December	2,828.3	33.7	4.78	5.18	0.113	0.122	0.009
Total	43,282	514.4		**Total**	**5.990**	**6.024**	**0.034**

	Annual ave. intake Hg concentration (ng/l)	Annual ave. effluent Hg concentration (ng/l)	Annual intake Hg mass (lbs)	Annual effluent Hg mass (lbs)	Total Annual Hg mass Introduced/removed (lbs)
Annual Average	13.44	12.64	4.851	4.561	-0.290
Std Deviation	13.2	11.1			
Variance	173.2	122.4			
Correlation coefficient	0.887				
t-test	0.329				

Monthly Hg Mass = flow (Mgal/month) * 8.34 lb/gallon * Monthly Hg concentration (mg/l)
Annual Hg mass = Annual total flow (Mgal/year) * 8.34 lb/gal * Annual Ave. Hg concentration (mg/l)

Plant discharge includes circulating cooling water flow and discharge from the wastewater treatment facility.

3 Mercury Reduction Options

Three options to reduce mercury in the Pulliam Power Plant's wastewater discharge are described in detail in the following sections:

3.1 Reverse Osmosis Boiler Water Pretreatment
3.2 Regeneration Water Treatment
3.3 Demineralization Chemical Substitution
3.4 Combination RO Boiler Water Pretreatment and Demineralization Chemical Substitution

3.1 Option 1 - Reverse Osmosis Boiler Water Pretreatment

3.1.1 Design

An RO boiler water pretreatment system has been designed as shown on Figure 1. This system would be installed upstream of the existing boiler demineralizers. The RO system consists of:

- Duel RO banks (140 gpm each) and supporting pumps,
- A permeate storage tank,
- Duplex permeate pumps,
- A dechlorination feed system,
- An antiscalant feed system, and
- A clean in place (CIP) system.

The system is designed for the maximum permeate flow of 280 gpm. This is the same as the existing combined capacity of the ion exchange demineralizers. The maximum feed to the system is estimated at 370 gpm with 90 gpm of RO concentrate pumped to the wastewater treatment plant. The RO concentrate should not affect the treatment facility as 90 gpm represents approximately 5% of the current Wastewater Treatment Plant (WWTP) flow. The RO concentrate will not appreciably affect the character of the wastewater treatment effluent as the concentrate will have minimal biochemical oxygen demand (BOD) or suspended solids. Mercury concentrations of the RO concentrate are expected to be minimal as the source water is potable. The RO twin units will have a footprint of 8 feet by 24 feet long. The remaining equipment will have a footprint of 10 feet by 20 feet.

3.1.2 Benefits

Installation of an RO water pretreatment system will reduce the number of regeneration cycles of the existing demineralizer system by an estimated 90%. A 90% reduction in the number of regenerations will result in a 90% reduction in chemical usage. Therefore, the amount of mercury contributed by both the caustic soda and sulfuric acid will also be reduced by 90%. The estimated potential reduction in mercury is shown in Table 3-1. This potential reduction calculation is based on maximum potential mercury concentration of 1 parts per million (ppm) in the sulfuric acid and 0.5 ppm in the caustic soda. The maximum mercury concentrations are based on chemical manufacturer's data. The cost savings are included in the operating cost estimate (Appendix B).

Table 3-1

Potential Reduction in Mercury from Reduced Chemical Usage

Demineralization Activity	Regenerations per year[2]	Chemical per Regeneration[2] (gal)	Chemical Used (lb/yr)	Mercury in chemcial[3] (lb/yr)
Sulfuric Acid[1]				
A – Lead Unit	180	192	329,357	
A – Mixed Bed	1	192	1,830	
B – Lead Unit	252	138	331,415	
B – Mixed Bed	2	138	2,630	
		Total	665,232	0.665
			Reduction	90%
Mercury potentially reduced from reduced sulfuric acid use, lb/yr				0.599
Caustic Soda[1]				
A – Lead Unit	180	37	84,915	
A – Mixed Bed	1	31	395	
B – Lead Unit	252	70	224.910	
B – Mixed Bed	2	55	1,402	
			311,623	0.156
			Reduction	90%
Mercury potentially reduced from reduced caustic soda usage, lb/yr				0.140
Mercury potentially reduced from reduced chemical usage, lb/yr				**0.739**

Notes:
1. Sulfuric acid basis: 20% solution, density = 9.53 lb/gal, mercury concentration is maximum 1 ppm,
   Caustic Soda basis: 50% solution, density = 12.75 lb/gal, mercury concentration is maximum 0.5 ppm.
2. Data provided by WPS (A and B Demineralizer Lead Unit Regeneration Log Data).
3. Mercury introduced in pounds per year from demineralization chemicals are estimated using the formula:

$$\frac{gal\ chemical}{regeneration} \times \frac{regenerations}{year} \times density\ of\ solution\ \frac{lb}{gal} \times ppm$$

Prepared by: AKM
Checked by: JJF1

3.1.3 Cost Estimate

A cost estimate of capital and operating costs appears in Appendix B. In summary, the estimated capital cost is $750,000. The annual savings of demineralizer chemicals is estimated at $97,000 per year. The operation and maintenance cost is estimated at $83,000. (The net annual operational savings of installation of this RO system is $14,000.)

3.2 Option 2 - Regeneration Water Treatment System

3.2.1 Design

As noted in Table 2-1, the demineralizer regeneration wastewater contains mercury as a result of the demineralizer system regeneration process and use of sulfuric acid and caustic soda chemicals. This regeneration wastewater can be chemically treated to reduce mercury concentrations prior to treatment in the existing wastewater treatment facility. The regeneration water treatment system consists of a metals removal system by utilizing coagulation/precipitation and flocculation of metals in the wastewater as shown on Figure 2.

Regeneration water is routed through one of two 10,000-gallon storage and equalization tanks where pH is adjusted using caustic soda and sulfuric acid. The water is then pumped to a 500-gallon reactor tank where a coagulant and thio-organic chemicals are added to precipitate metals. Retention time in this tank is 5 to 20 minutes. The reactor effluent flows to a 500-gallon tank where a polymer is added to encourage flocculation. Effluent flows to a clarifier where liquid is drawn off the top and sludge is pumped to a solids thickener. The thickened solids are pumped through a plate and frame press. Solids are ready for containerizing and disposal to a landfill. Supernatant is rerouted to the facility WWTP.

3.2.2 Benefits

The performance of solids removal for this system is anticipated to remove approximately 84% of mercury from the regeneration waste stream. The estimate of reduced mercury is based on the combined flows of demineralizer acid and caustic regeneration streams as shown on Table 2-1 and as shown in Table 3-2:

Table 3-2

Reduction in Mercury from Regeneration Water Treatment System

Mercury in Regeneration Water	Mercury Concentration[1] (ng/L)	Water Flow Rate[1] (MGD)	Mass Flow Rate of Mercury[1] (lb/yr)
Demineralizer acid regeneration	58.0	0.0055	9.7E-04
Demineralizer caustic regeneration	5.23	0.0055	8.8E-05
Total regeneration stream	31.6	0.011	0.00106
Mercury reduction from regeneration water treatment system[2]			84%
Mercury reduction by treatment of regeneration water lb/yr			**0.00089**

Notes:
1. Data presented in Table 2-1.
2. Reduction based on engineering judgment and a treatment system discharge of 5 ng/L mercury.

Prepared by: AKM
Checked by: JJF1

3.2.3 Cost Estimate

A cost estimate of capital and operating costs appears in Appendix B. In summary, the capital cost is $738,000, and the annual operations and maintenance cost is $85,000.

3.3 Option 3 - Demineralization Chemical Substitution

3.3.1 Design

There are no designs associated with this option. Currently, sulfuric acid and caustic soda is used in the regeneration of the demineralizer resin beds. WPS uses membrane cell caustic soda, the highest grade commercially available. Caustic soda is not available with reduced mercury content. WPS has found that chemical suppliers of sulfuric acid have quality control acceptance criteria with a maximum mercury concentration of up to 1 ppm. Sulfuric acid is also commercially available with a maximum mercury concentration of 0.1 ppm.

3.3.2 Benefits

The benefits of this option are the direct reduction of mercury in the wastewater discharge. Mercury reduced is based on composition reduction in sulfuric acid from an estimated 1 ppm to 0.1 ppm. Based on reducing the concentration of mercury in the sulfuric acid by up to 90%, the mass of mercury in wastewater discharge could be potentially reduced as shown in Table 3-3.

Table 3-3

Potential Reduction in Mercury from Sulfuric Acid Substitution

Sulfuric Acid Used[1] (lb/yr)	Mercury in Sulfuric Acid[1] (lb/yr)
665,232	0.665
Reduction	90%
Mercury reduction by sulfuric acid substitution (lb/yr)	**0.599**

Notes:
1. As shown on Table 3-1.

Prepared by: AKM
Checked by: JJF1

3.3.3 Cost Estimate

There are no cost implications for this option. WPS has contacted suppliers of these chemicals and lower maximum mercury concentration levels of sulfuric acid, 0.1 ppm vs. 1 ppm, are available at no additional charge.

3.4 Option 4 - Reverse Osmosis Boiler Water Pretreatment with Chemical Substitution

Option 4 is a combination of Option 1 (described in Section 3.1) and Option 3 (described in Section 3.3). The capital and operating cost are the same as Option 1 costs since there are not costs associated with Option 3.

Mercury reduction achieved by the installation of the RO system will be supplemented with an additional reduction from chemical substitution for sulfuric acid (mercury concentration of 1 ppm reduced to 0.1 ppm). Table 3-4 presents the results.

Table 3-4

Option 4 Mercury Reduction

Item	Chemical Used (lb/yr)	Potential Mercury in chemical (lb/yr)
Sulfuric Acid		
Sulfuric acid used, (Table 3-1)	665,232	0.665
Reduction from RO pretreatment		90%
Mercury potentially reduced from reduced sulfuric acid use (Option 1)		**0.599**
Mercury remaining		0.067
Reduction from chemical substitution		90%
Potential reduction from chemical substitution (Option 3)		**0.060**
Caustic Soda		
Caustic soda used, (Table 3-1)	311,623	0.156
Reduction		90%
Mercury potentially reduced from reduced caustic soda use (Option 1)		**0.140**
Mercury potential reduction from RO pretreatment and chemical substitution (Option 4), lb/yr		**0.799**

Prepared by: AKM
Checked by: JJF1

4 Summary and Conclusions

The capital costs, annual operating costs, and reduction of mercury in the authorized wastewater discharge stream are summarized in Table 4-1.

Table 4-1

Summary of Capital Cost, Operating Cost, and Potential and Estimated Mercury Reduction of Options 1 through 4

Option	Description	Capital Cost ($)	Operating Cost ($/year)	Potential Mercury Reduction (lb/yr)	Estimated Mercury Reduction[1] (lb/yr)
1	RO Boiler Water Pretreatment	750,000	Savings of 14,000	0.739	0.00095[2]
2	Demineralizer Regeneration Water Treatment	738,000	85,200	n.a.	0.00089
3	Demineralization Chemical Substitution	0	0	0.599	0.00087[3]
4	RO Boiler Water Pretreatment with Chemical Substitution	750,000	Savings of 14,000	0.799	n.a.

Notes

1 Estimated mercury reduction based on wastewater sampling data and Table 2-1.

2 Estimated mercury reduction is based on 90% of the demineralizer acid and caustic regenerant mass flow rates from Table 2-1. (0.9 x (9.7E-04 + 8.8E-05)).

3 Estimated mercury reduction is based on 90% of the demineralizer acid regenerant mass flow rates from Table 2-1. (0.9 x 9.7E-04).

4 n.a. - not applicable

Prepared by: AKM
Checked by: JJF1